ASPECTS OF THE LIFE HISTORY AND FISHERY OF RED PANDORA, *PAGELLUS ERYTHRINUS* (SPARIDAE) OFF WESTERN GREECE

by

C. PAPACONSTANTINOU (1), C. MYTILINEOU (1)
and T. PANOS (1)

ABSTRACT. - *Pagellus erythrinus* was studied off the western coast of Greece during 1983-85, to obtain information on its life history and identify existing or potential threats to its survival. Marginal increment analysis revealed that annuli were formed once each year between June and September. The relationship between scale length (R) and fish length (FL) was linear. *P. erythrinus* showed a relatively rapid growth between I-II age groups, followed by little or no growth later. The maximum life span was 10 and 13 years for respectively males and females. Males tended to be slightly heavier at an equal length than females. Little seasonal fluctuation in condition factor was noted for each sex. *P. erythrinus* were fully recruited by the local trawl fishery at age 3. A Beverton and Holt yield-per-recruit model (M = 0.22) suggests a maximum yield-per-recruit of 1956 g.

RÉSUMÉ. - *Pagellus erythrinus* de la côte Ouest de la Grèce à été étudié de 1983 à 1985, afin d'obtenir des renseignements sur l'histoire de sa vie et de connaître les causes existantes ou possibles qui menacent sa survie. L'analyse des accroissements successifs des écailles a révélé que les annuli se formaient une fois par an, entre juin et septembre. Le rapport entre la longueur de l'écaille et la longueur du poisson est linéaire. *P.erythrinus* présente une croissance relativement rapide pour les groupes d'âge I-II, puis une croissance faible ou nulle. La plus grande longévité est de 10 et 13 ans pour, respectivement, les mâles et les femelles. Les mâles tendent à être un peu plus lourds, à longueur égale, que les femelles. On a remarqué peu de changement saisonnier du facteur de condition pour les deux sexes. La pêche au chalut capture tous les P. *erythrinus* âgés de 3 ans. Le modèle du rendement par prise (M = 0.22) de Beverton et Holt suggère un maximum de 1.956 g.

Key-Words : Sparidae, *Pagellus erythrinus*, MED, Greece, Age determination, Growth.

Pagellus erythrinus L., 1758, is a sparid fish whose geographical distribution extends from the Black Sea and the Mediterranean, along the west coast of Europe and Africa from Angola to Norway (Tortonese, 1975), although it is notably rarer in the northern part of its range (Wheeler, 1969). Its bathymetric range extends from the shallow sublittoral down to about 120 m, but it is most common at depths of about 60 m.

Various aspects of the life history of *P. erythrinus* have been studied in different sea areas of the Western and Central Mediterranean, but there are few published data from the Eastern Mediterranean (Mouneimne, 1978 ; Papaconstantinou, 1984 ; Vassilopoulou *et al.*, 1986). Several authors have summarized and discussed the occurence and life history of the species off the Castellon coast (Larraneta, 1964, 1967), in the Adriatic Sea (Zupanovic and Rijavec, 1980), in the Libyan waters (Hashem and Gassim, 1981) and in the Gulf of Lion (Girardin and Quignard, 1985). Ghorbel and Ktari (1982) give an account of the reproductive cycle of the species off the Tunisian coast and Mytilineou (1987) off the western coast of Greece. Ardizzone and Messina (1983) studied the feedeng habits off the Tyrrhenian coast, Rosecchi (1983) in the Gulf of Lion, and Caragitsou and Papaconstantinou (1985) in the Saronikos Gulf (Greece).

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(1) National Centre of Marine Research. Athens 16604, GREECE.

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The commercial value and abundance of red pandora in Greek waters make necessary a better understanding of its biological role. This paper presents the results of the initial phase of a broad study of red pandora biology off the western coast of Greece. The objective were to determine length composition of the catch, to obtain growth estimates and to study the mortality rates.

MATERIAL AND METHODS

Between June 1983 and April 1985, seasonal samples of *Pagellus erythrinus*, amounting to 2710 specimens, were obtained from catches of a 425 HP commercial trawl, towing a net with a cod-end mesh of 28 mm between stretched knots, in the coastal waters off western Greece (Fig. 1). Fork length (FL) to the nearest mm, weight to the nearest g, sex and gonad maturity, when possible, were recorded.

Age was determined by scale reading. Distances from the focus to each annulus and to the margin were recorded from scales of 1067 *P. erythrinus*. Scales were taken from the left side just down the lateral line in an area, below the tip of the pectoral fin. Scales were cleaned in 5 % sodium peroxide and their impressions were made by placing several scales from each fish on a strip of 0.25 inch-thick cellulose acetate and applying pressure of 800 Kp/cm2, at 80°C by a CARVER auto-press. Scales impressions were viewed at a x 40 diameter magnification obtained with a scale projector. All malformed, regenerated and otherwise atypical scales were discarded. A representative non-regenerated scale on each slide was read twice, with a period of at least two months between successive readings. If agreement was not reached after two readings, the scale was discarded.

Mortality estimates were calculated separately for males and females by the catche curve, or regression method of Ricker (1975) and Pauly (1983).

Annulus validation.

In the centre of each scale, an hyaline nucleus can be clearly distinguished, surrounded by an opaque area. It is assumed that the nucleus was formed during the

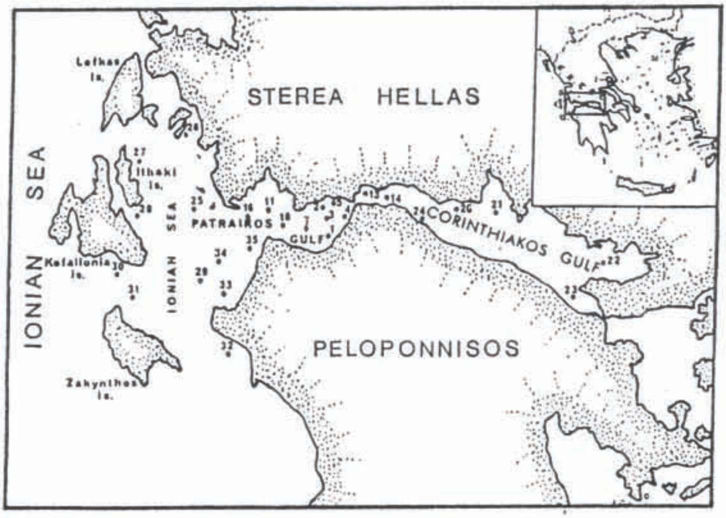

Fig. 1 : Map of the sampling areas showing the fishing stations.

stage which the young-of-the-year *P. erythrinus* live close to the coast, in a depth between 2-4 m, when the fish was 30-40 mm (summer-fall).

The most abundant, and most available throughout the year, age groups of *P. erythrinus* (I to V), were used to determine the time of annulus formation (Table I). Measurements of the scales were made from the focus to both the angle of the antero-lateral margin (R) and that of the last annulus-growth mark (Rn). The difference between these two measurements was considered as the growth increment since the last annulus was formed. Table I shows the seasonal mean absolute growth increment (R-Rn) and its percentage in relation to the mean scale radius of each age group. The annulus formation occurs during the period June to September and varies with fish size. The minimum of the marginal scale increment of the first age group appears between June and September, whilst for all other age groups in June. The data of Table I suggest that only one annulus is formed per year, the margin increments increasing progressively through autumn and the begining of winter to attain values corresponding to those just before the start of new growth.

RESULTS

Size composition

A length-frequency diagram, separately for each sex, was drawn from the measurement (observed length) of 2710 *P. erythrinus* over the period June 1983 to April 1985. Both sexes were ranged in length from 43 to 322 mm or from 0 to XIII years old (Fig. 2). Records of age composition according to sex showed a predominance of females almost in all age groups and, especially, in age group I through V, reflecting the protogynous hermaphroditism of the species. Since spawning of the species was not restricted to a definite period of the year (April through October), the length frequency distribution could not represent definite age groups.

The first sample collected in June 1983 by trawl showed two dominant modes between 8-11 cm and 12-14 cm, representing age groups I and II, which hatched in

Table I : Mean marginal scale increment in magnification units, by age group, on various dates during the year (June through March). One magnification unit equals 0.025mm. R = distance between focus to the anterior margin ; Rn = distance between focus to the last annulus growth mark ; N = number of sample.

Age		0	I	II	III	IV	V
June 1984	N	13	36	36	11	2	2
	R	92	116.3	140.4	163.0	184.0	204.5
	R - Rn	—	17.8	11.8	8.0	6.5	6.0
	%	—	15.3	8.4	5.0	3.5	3.0
September 1984	N	55	44	44	8	1	1
	R	82.4	115.0	143.0	164.0	187.0	199.0
	R - Rn	—	17.4	13.9	11.5	9.0	1.0
	%	—	15.0	9.7	7.0	—	—
November 1984	N	53	81	69	17	2	2
	R	82.0	119.0	143.0	167.0	181.0	201.0
	R - Rn	—	19.0	13.0	11.0	7.5	8.0
	%	—	16.0	9.0	6.6	—	—
March 1985	N	29	24	79	37	21	5
	R	90.0	120.0	142.0	169.0	190.0	208.0
	R - Rn	—	21.0	13.0	12.0	13.0	13.0
	%	—	17.0	9	7.1	6.8	6.3

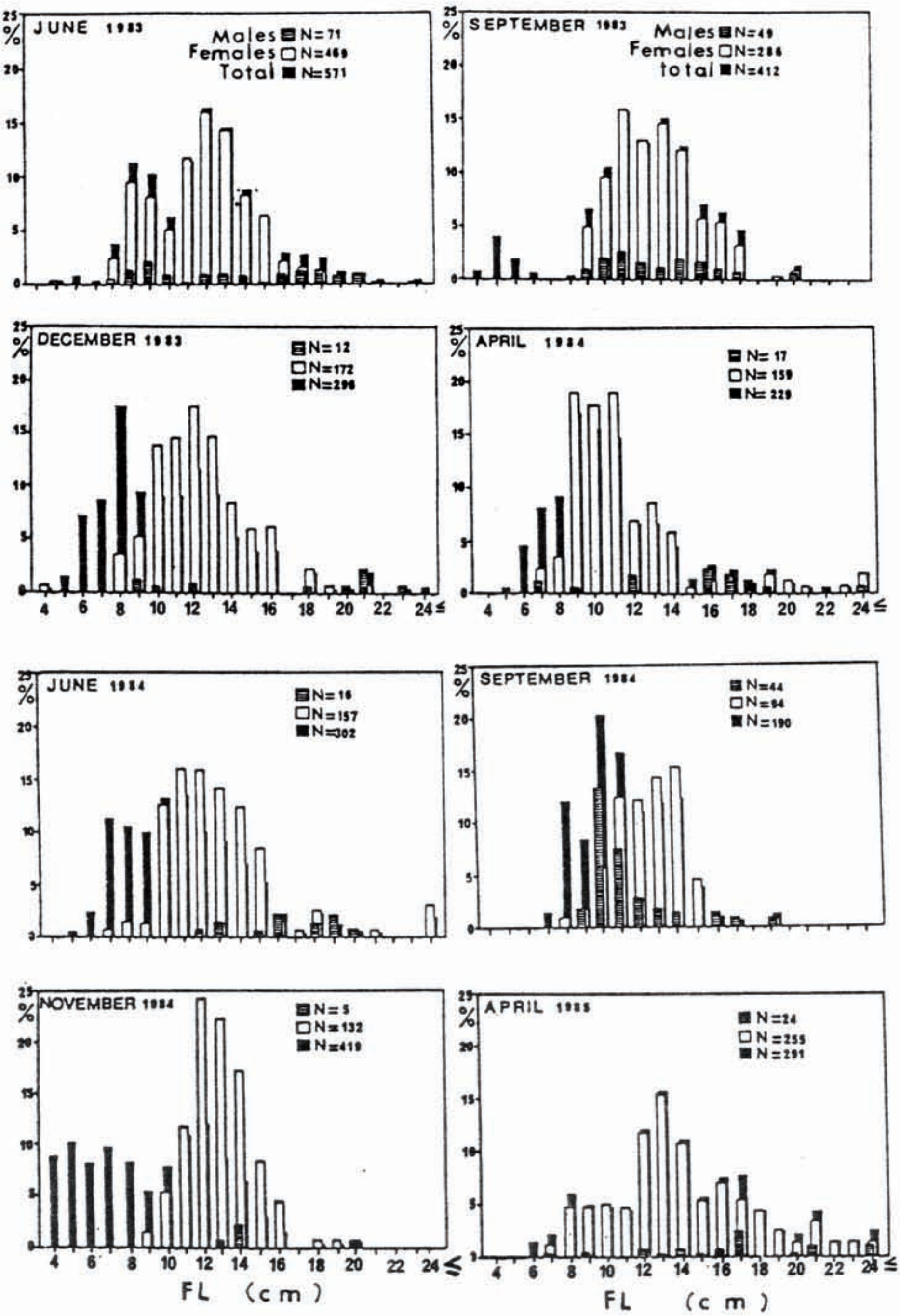

Fig. 2 : Length-frequency distribution of *Pagellus erythrinus* captured by trawl on seasonal collecting trips off the western coast of Greece from June 1983 through April 1985.

1981 and 1982 (Fig. 2). Young-of-the-year were about 4-6 and 6-9 cm long by the end of September and December 1983 respectively. Growth of this year class could be followed until November 1984, by which time the mean length had increased to 12.5 cm. Some of the longest specimens taken in 1984 were 137 mm long and represented the maximum observed size of one-year-old fish.

The high representation of young-of-the-year in November 1984 provides strong evidence that breeding was delayed that year. Data for the 1983 and 1984 year classes were adequate for demonstrating the seasonal growth pattern for the younger fish. Red pandora from both year classes grew slowly during the winter of 1983/1984 and increased in length rapidly during the following spring and summer.

A total of 387 juveniles of *P. erythrinus* was collected by seining (beach seine with a 8 mm -from knot to knot- mesh size) from Itea Bay (Korinthiakos Gulf) between October 1983 and May 1985 (Fig. 3). Their length was ranged between 28 and 160 mm, but it was interesting to study the fishes with a length not greater than 100 mm. They belonged to the 1983 (Fig. 3 a) and 1984 (Fig. 3 b) year classes and their growth could be followed until May 1984 and 1985 respectively.

Length-age relationship

The length distribution of the 1067 *P. erythrinus* used for age determination indicates small ranges in length for individual age groups and limited overlap between adjacent age groups (Table II). The mean length at the time of capture for age tested statistically with a Student's "t" test showed no significant differences ($P > 0.05$) between sexes. The greatest span between the longest and shortest fish in an age group was 60 mm (II, III group), but most age groups had a span of 30 or 40 mm. Only one of the length intervals (131-140 mm) contained fish of more than two ages. Length, therefore, appears to be a reasonably good index to the age of *P. erythrinus* off the western coast of Greece.

Age and growth

A series of "t" tests confirms that there are no significant differences between sex for the averaged back-calculated mean lengths at each age (I to X age group). However, although the back-calculated mean length at each age were almost similar, the sexes were not combined for the preparation of Tables III and IV because of the hermaphroditism of the species, the sex ratio, the number of females which were significantly higher than males in all cohorts, and the greater longevity of females.

The linear relationship between the fork length (FL) in mm and the scale radius (R) in mm x 40 was calculated for males and females. Coefficients of correlation, determination, standard error estimates and biological meaning indicated that curvilinear relationship would not improve the selection. The analysis of covariance showed that there was a difference between sexes ($F = 20.2$, $df = 1027$, $P < 0.05$). These relations were obtained from 923 females and 144 males, ranged from 75 to 322 mm and from 75 to 275 mm long respectively.

Female : $FL = 21.3 + 0.8\ R$
Male : $FL = 15.0 + 0.9\ R$

There is no sudden divergence in the growth patterns. The average of the annual growth increment is greatest in both sexes during the first year of life and decreases steadily until the seventh year. After the seventh year, it increases abruptly for the next two years. It is possible that an increase in growth occurs after sexual inversion, although it is limited, because of the slow growing nature of the fish. Moreover, the limited number of the old individuals and the difficulty to "read" the scales of the older individuals are connected with the above results.

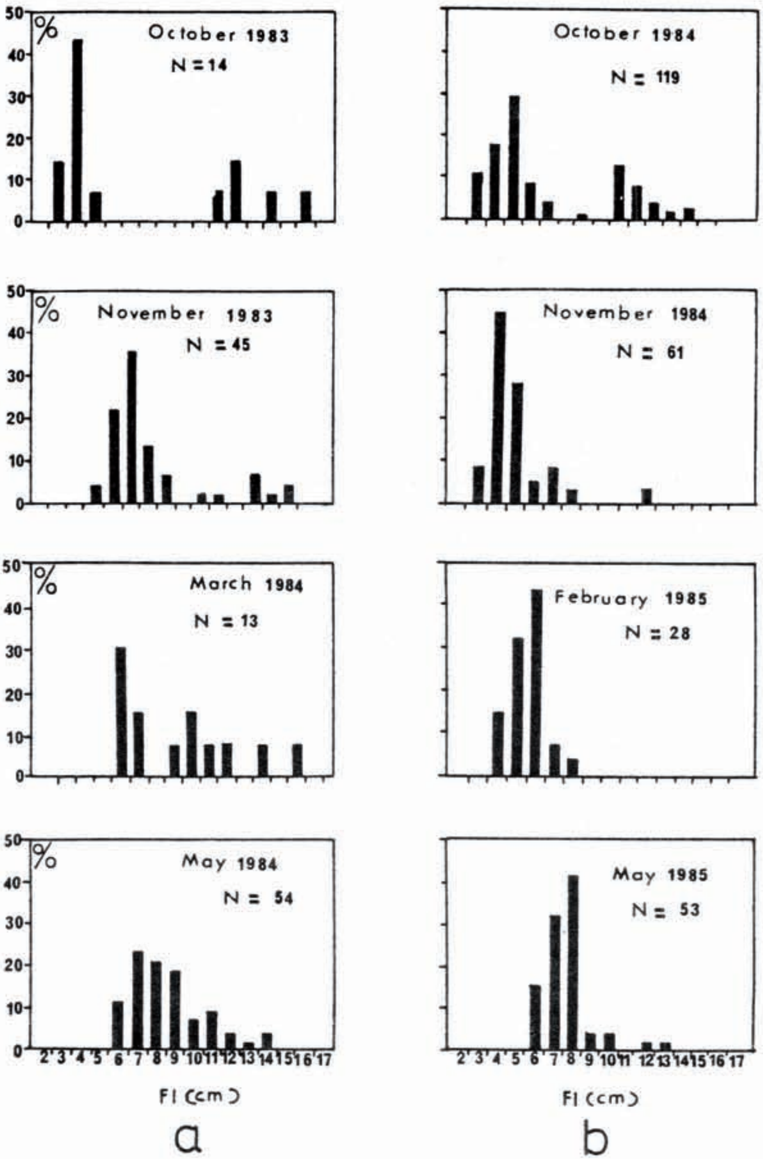

Fig. 3 : Length frequency distribution of *P. erythrinus* captured by beach seine in the Itea Bay (Korinthiakos Gulf) from October 1983 through May 1985.

Growth rate was calculated using von Bertalanffy (1957) growth equation as modified by Lopez Veiga (1979) :

$$L_t = L\infty\ (1 - e^{-k\ (t - t_0)})$$

where Lt = fork length at age t, L∞ = maximum or assymptotic attainable size, k = growth coefficient, Lo = the size of the individuals when t = 0. We should interprete Lo as the length of the larvae at hatching.

Table II : Fork length distribution of the age groups of females (F) and males (M) red pandora of the West Coast of Greece : June 1983-1985.

Age groups	0		I		II		III		IV		V		VI		VII		VIII		IX		X		XI		XII		XIII			
Length Classes in mm	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	Sub. to M	F
71 - 80	3	4																											3	4
81 - 90	1	15																											1	15
91 - 100	8	37		1																									8	38
101 - 110	12	30	8	35																									20	65
111 - 121			12	96		1																							12	97
121 - 130			6	107	5	59																							11	166
131 - 140			1	13	7	156		2																					8	171
141 - 150					13	138		7																					13	145
151 - 160					1	25	3	61																					4	86
161 - 170						4	11	42		6																			11	52
171 - 180							5	7	10	11																			15	18
181 - 190								2	8	17	1																		8	20
191 - 200									3	1	6	12		2															9	15
201 - 210											1	3	6	3															7	6
211 - 220													3	3	7	6													10	9
221 - 230																2		1											-	3
231 - 240																1	1	2											1	3
241 - 250																	1	1											1	1
251 - 260																				2									-	2
261 - 270																					1	1							1	1
271 - 280																					1	1							1	1
281 - 290																						1		1					-	2
291 - 300																								1					-	1
301 - 310																								1					-	1
311 - 321																													-	-
321 - 330																												1	-	1
N	24	86	27	252	26	383	19	121	21	35	8	15	9	8	7	9	2	4	-	2	2	3	-	3	-	-	-	1	144	923
Mean Length	07.0	95.8	115	118	138	138	166	159	181	178	195	197	208	206	215	219	240	235	-	255	275	273	-	295	-	-	-	325		

From the available data the equation expressing the growth in length is :

$$L_t = 326\ (1\text{-}e^{\,-\,0.18\,(t\,+\,0.04)})$$

Length-weight relationship

The data used for the length-weight analysis ($W = a.L^b$, where W = weight in g, L = length in mm, a and b = constants) were collected from 1572 females and 220 males. A pooled regression for each sex computed from all available data revealed the following length-weight relationship :

$$\text{Males : } W = 0.000016.\ L^{3.025},\ r = 0.975,\ n = 220$$
$$\text{Females : } W = 0.000020.\ L^{2.979},\ r = 0.984,\ n = 1572$$

Males tend to be slightly heavier at equal length than females. Since differences in length-weight relationships occur between sexes and season for many species (Bagenal and Tesch, 1978 ; Le Cren, 1951), equations for *P. erythrinus* were developed by the least squares method for each sex, maturity stage and calendar quarter based on the length and weight of the 1488 individuals obtained in 1983-84 (Table V). Slopes of the above length-weight relationship were ranged from 2.754 to 3.196. Most of the slopes were greater than 3.0, indicating that longer fish were relatively plumper than shorter fish.

The slope of the length-weight relationship, for both sexes, attained higher values in fall and winter, as compared to spring and summer. The slope for males, was greater in summer than in spring, whereas the opposite is true for females. Slopes for both sexes were almost identical in fall.

Table III : Summary of the mean calculated fork lengths in millimeter and increments of growth for male *Pagellus erythrinus* collected off westem coast of Greece, 1983-1985.

Age Group	Number of fish	Calculated fork lengths (mm) at each year of life									
		I	II	III	IV	V	VI	VII	VII	IX	X
I	27	100,3									
II	26	100,2	127,8								
III	21	102,7	133,7	157,1							
IV	19	104,9	133,6	156,4	174,4						
V	8	99,8	132,8	157,2	176,8	191,6					
VI	9	100,9	137,5	163,0	179,7	192,9	204,2				
VII	7	99,5	130,3	154,3	172,3	186,6	199,7	211,7			
VIII	2	100,7	130,6	151,3	169,3	187,8	201,0	212,7	226,9		
IX	0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	
X	2	104,7	136,8	158,5	179,8	197,6	214,4	227,8	240,8	254,2	265,3
Total number 121		101	94	68	47	28	20	11	4	2	2
Grand average calculated length (in mm)		101,5	132,1	157,7	175,5	190,9	203,3	214,8	233,9	254,2	265,3
Increment of growth (in mm)		101,5	70,6	25,2	18,2	15,4	12,4	11,4	19,1	20,3	11,1

Table IV : Summary of the mean calculated fork lengths in millimeter and increments of growth for male *Pagellus erythrinus* collected off westem coast of Greece, 1983-1985.

Age Group	Number of fish	Calculated fork lengths (mm) at each year of life												
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
I	252	102.7												
II	384	102.6	129.3											
III	121	103.6	130.6	151.6										
IV	35	104.7	132.2	153.9	171.5									
V	15	103.7	132.6	157.4	174.9	187.8								
VI	8	105.8	134.6	157.3	175.9	190.3	203.0							
VII	9	104.1	132.4	156.2	175.8	190.7	204.0	214.6						
VIII	4	99.5	127.7	148.2	168.2	186.7	202.4	216.2	230.3					
IX	2	106.5	139.2	161.0	182.7	195.7	211.0	225.3	238.8	249.3				
X	3	105.5	136.0	162.1	182.5	201.4	222.6	238.8	252.5	264.4	273.4			
XI	3	102.0	133.0	158.8	179.8	196.5	215.5	233.9	253.4	268.7	277.6	286.7		
XII	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
XIII	1	101.7	136.9	159.5	174.6	188.9	201.4	214.0	226.6	239.1	251.7	266.8	283.5	293.6
Total number 837		837	585	202	80	45	30	22	13	9	7	4	1	1
Grand average calculated length (in mm)		103.0	130.0	153.2	173.9	190.5	206.5	221.4	239.7	254.5	269.6	281.7	283.5	293.6
Increment of growth (in mm)		103.0	27.1	23.2	20.7	16.6	16.0	14.9	18.3	14.8	15.1	12.1	1.8	10.1

The Fulton's condition factor of individual *P. erythrinus* was calculated and seasonal mean values for each sex were determined. Little seasonal fluctuation in condition factor was noted (Fig. 4). Throughout the year, the condition factor for males is slightly higher than that for females. It remained almost constant throughout the year, with slightly higher values in spring for both sexes, a period just during high reproductive activity intensity. Gonad weight, when added to the body weight, produces a seasonal maximum in the condition factor.

Table V : Regression analysis of fish weight on fish length by sex, season and maturity stage categories of *Pagellus erythrinus*.

	n	a	b	r	FL (in mm)
MALES					
Spring	34	0.000036	2.88	0.995	78 - 272
Summer	77	0.000016	3.02	0.977	57 - 268
Fall	85	0.000007	3.20	0.983	130 - 235
Winter	15	0.000009	3.13	0.997	95 - 220
FEMALES					
Spring	105	0.000011	3.11	0.985	73 - 322
Summer	420	0.000012	3.07	0.966	80 - 303
Fall	220	0.000007	3.19	0.986	87 - 216
Winter	140	0.000007	3.17	0.982	90 - 217
HERMAFROD.	27	0.000006	3.22	0.990	130 - 228

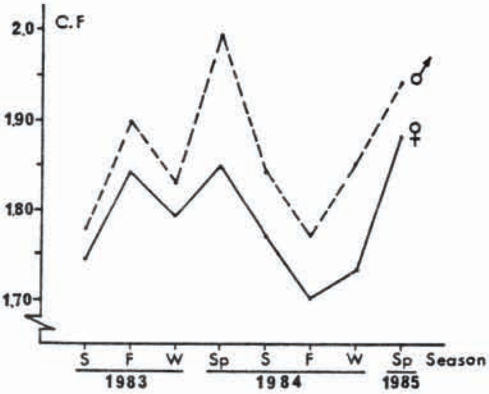

Fig. 4 : Seasonal variations of condition factor from summer 1983 to spring 1985.

Mortality rates

Since *P. erythrinus* were not fully recruited to the trawl fishery until length 12.5 cm, total mortality from catch-curve was based on fish length 12.5 cm and over. Total mortality (Z) was estimated after Pauly (1983). Natural logarithms of the number of fish in length groups, divided by a correction factor, were plotted against estimated relative age to produce a length converted catch curve ; in our case 10 mm groups were taken from the data used to construct the frequency polygon shown in Figure 5. The slope of the descending right limb of the curve estimates the mean annual instantaneous total mortality (Z). It was 1.13 (S = 0.32 ; A = 0.68) for both years combined (N = 2710), 1.3 (S = 0.27 ; A = 0.73) for 1984 (N = 1507) and 0.92 (S = 0.40 ; A = 0.60) for 1985 (N = 1203) (Fig. 5) where S is the annual survival rate and A is the annual mortality rate. With the same method, Relini-Orsi and Romeo (1986) calculated that Z = 1.5 in the Ligurian Sea.

Pauly (1983) demonstrated that natural mortality (M) is correlated to the mean environmental temperature in which the stock lives according to the equation : $\log M = -0.0066 - 0.279 \log L_\infty + 0.6543 \log K + 0.4634 \log T$. The annual mean temperature of the study area is 14.7 ° C. Thus M was estimated at 0.22 and the fishing mortality (F) at 0.91. The exploitation rate (E), calculated according to the formula : $E = F / F + M$, was found to be rather high (E = 0.81) indicating that the stock of *P. erythrinus* was heavily overfished, as it is usually assumed that the stock is fully fished when M = F and E = 0.50.

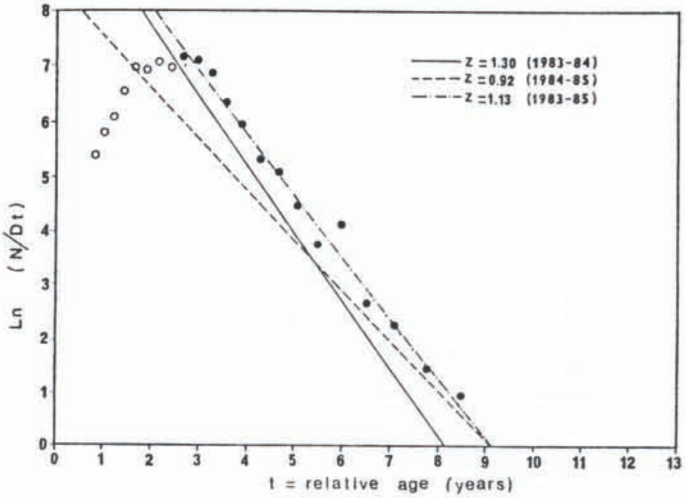

Fig. 5 : Age frequency distribution of *P. erythrinus* in the trawl catch along the western coast of Greece (z = total mortality).

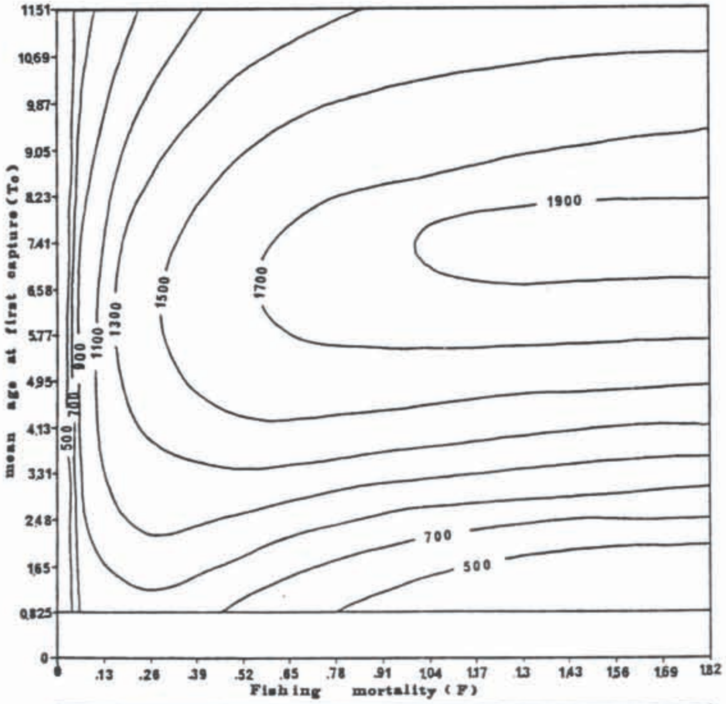

Fig. 6 : Yield-per recruit model for *P. erythrinus* (F : fishing mortality ; T : mean age at first capture ; M = 0.22 ; K = 0.18 ; L = 326 mm ; to = 7-8 years).

Yield per recruit

Yield is the proportion of a fish population taken by man. There are numerous ways of estimating yield and potential yield, generally referred to as analytical dynamic pool models. Since the dynamic pool models for yield determination consider explicitly the effects of growth and mortality on biomass, we used the yield-per-recruit model according to Pitcher and Hart (1982). Three parameters in this yield model may be controlled by management agencies : the intensity of fishing mortality (F), the age of entry into the fishery (t1) and, in some situations, maximum age in the fishery. With instantaneous natural mortality (M), growth parameters (L∞, W∞, K), and tc held constant, there is generally a value of F which produces a maximum yield. The figure also shows the effects of different levels of tc for M constant (= 0.22). Plotting tc against F provides the yield isopleth diagram (Fig. 6).

Growth parameters K, L∞, W∞ were derived from the von Bertalanffy equation. M for *P. erythrinus* was estimated using Pauly's (1983) relationship. The yield model suggests that trawl fishery could obtain a maximum yield of 1956 g per recruit with F = 0.9-1.0 and tc = 7-8 years.

From the fishing mortality (F) and the selection factor (Tsimenidis, pers. com.) it is inferred that MSY could be obtained by increasing both the mesh size (55-65 mm) and holding the fishing mortality constant. The model shows that when F increases with tc constant (tc = 2.68), Y/R goes down. On the contrary, increasing tc with F constant improved the yield-per-recruit (Fig. 6). The above are better shown in Figure 7 where t has the limit values of tc (tc = 0.825 ; tc = 11). From a similar research, (Girardin, 1980) performed in the Gulf of Lion, the same model gave MSY values smaller than those found in this study for the same M = 0.20.

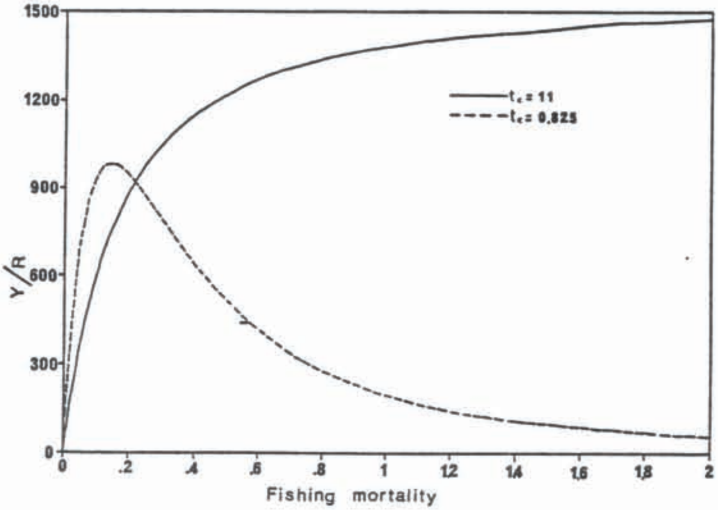

Fig. 7 : Yield-per-recruit model for *P. erythrinus* (F : fishing mortality ; Y/R : yield-per-recruit ; t : mean age at first capture ; M = 0.22).

DISCUSSION

Most of the difficulties in this study arise from the extremely slow, and relative variable growth of *Pagellus erythrinus*. Much longer samples would be needed to reduce the variability and provide more males for study. The reason for the poor rate of growth after the second year class of *P. erythrinus* may be associated with the onset of maturity, which often causes a discontinuity in the growth curve (Beverton and Holt, 1957). Mytilineou (1987) mentions that the first maturity of *P. erythrinus* takes place during the second year of his life. Another reason may be the heavy fishing causing a bias in the remaining population in favour of the younger year classes. The age structure of the population in the sampling area has the characters of a well-fished stock in that it consists of few large old fish. This structure differs in areas where trawl-fishing is prohibited, as Papaconstantinou (1984) mentions about Pagasitikos Gulf.

Several factors, however, support the reliability of the age determination method used. The scales show relatively clear annual rings, allowing accurate ageing ; the mean marginal increment made in the younger age groups drops in summer each year and the calculated and observed length showed close agreement. These observations indicate a correct recognition of annuli for fish in the younger

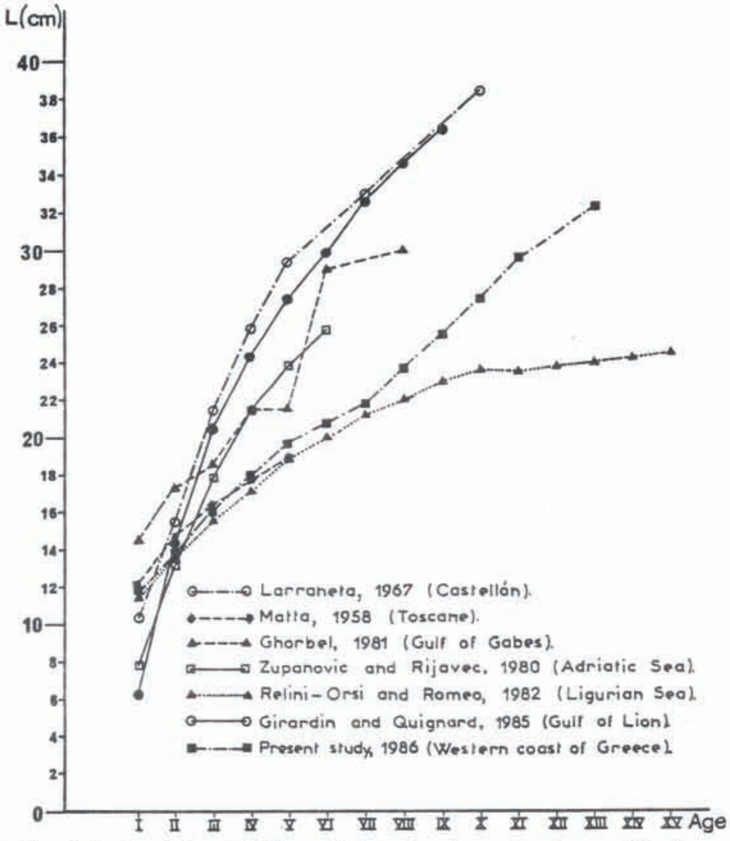

Fig. 8 : Growth in length (mm) of *P. erythrinus* (females and males combined) compared with growth of other mediterranean areas.

year classes and provide further evidence to that previously given (Girardin and Quignard, 1985) for the validity of the methods used.

The first annual mark is not formed at exactly one year, because of the protracted spawning season of the species ; *P. erythrinus* spawns as early in April and as late in October in the study area (Mytilineou, 1987). Fish that hatched in late fall did not form a mark within a few months of hatching. Indeed, none of the fish found the following May with lenghts between 50-75 mm had formed the first annual mark. As it is shown possible, from the above, the first mark is formed more than 12 months after hatching and is counted as an annual mark. In contrast, fish hatched early (spring, late summer) form the first strong mark in a period a few months shorter than a year. All marks after the first one would have been at annual intervals.

Seasonal fluctuation in the condition factor is rather small. As the fish feeds at almost the same rate all the year, except for significantly higher feeding activity during spring (Caragitsou and Papaconstantinou, 1985) and also spawns almost for half a year, no significant seasonal variation in the condition factor would be expected. However, the relatively high values in fall and spring for both sexes appear to be related with the feeding activity and the reproduction cycle. The observed reduction in the condition factor from November to December corresponds to the expected loss of gonadal tissue due to spawning, as the gonadosomatic ratio at this time is very low (Ghannudi, 1980).

The fastest growth rate for *P. erythrinus* in Mediterranean waters is that given by Larraneta (1967) off the Castellon coast, Hashem and Gassim (1981) for the Libyan waters and Girardin and Quignard (1985) for the Gulf of Lion (Fig. 8). However, all authors' method of presentation appears to exaggerate the actual growth compared with our data because the first two have used the total length, whilst the third one the von Bertalanffy data. The Gulf of Lion (Girardin and Quignard, 1985) and the Adriatic sea (Zupanovic and Rijavec, 1980) seem to have fast growing populations. Other particularly good rates of growth have been observed in the Ligurian Sea (Relini-Orsi and Romeo, 1985). Our data show a very low growth which is very close to that reported by Ghorbel (1981) for the Gulf of Gabes and Matta (1958) for the Toscane Archipelagos.

One problem in using the described method of determining mortality rates is that small changes in the values of K or L_∞ can cause major changes in the value of M for small fish. In our case, a change in K of *P. erythrinus* from 0.18 to 0.13 results in a change of M from 0.22 to 0.17. The method also must meet the conditions required for using a "catch curve" which were discussed by Ricker (1975). A serious problem arises when samples are taken randomly from all age groups involved, since changes in population structure, which arise from seasonal and breeding migration patterns, are not properly accounted for. In an attempt to alleviate this problem, we have employed a strategy whereby samples are taken seasonally at different depths.

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